

# NORTHEASTERN FOREST EXPERIMENT STATION

## Semiannual Report Watershed Management Research

April 1, - September 30, 1965

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#### PROJECT 1601 - WATER YIELD IMPROVEMENT

##### More on winterizing stream-gaging stations

For our stream-gaging stations with combined V-notch weirs and San Dimas flumes, streamflow in the low flow winter periods is normally measured in the V-notch weirs. The flumes, however, are needed for measuring occasional mid-winter thaws and early spring runoff, therefore the flumes should be ready for recording high flows at any time. Ice development in these not only makes them inoperable but requires considerable effort to place them back in service. To eliminate ice formation this winter we are trying a simple heating device in the well (our flumes are modified so that there are wells on both sides of the parallel section and a common well or tunnel connects the two wells). A three inch steel pipe was welded inside the well beneath the flume and a large bunsen burner (26,000 BTU/hr. capacity) was installed at one end of the pipe. A thermocouple connected to a low-temperature thermostat (set "on" at 32°F. and "off" at 34°F.) regulates the flow of propane gas to the burner which is ignited by a continuous pilot light. Portable notch enclosing shelters of plywood and small propane gas-powered water heaters on floats have also been installed at all weirs in attempts to get better winter streamflow records.

##### Wind profiles

Some wind profiles were obtained during one week in July over a red pine plantation on the Pack Experimental Forest of the New York State College of Forestry in conjunction with the Syracuse research unit. Computations of roughness length and zero-plane displacement are not yet completed, but initial semilog plotting gave nearly straight lines during neutral (adiabatic) conditions showing a small zero-plane displacement and roughness nearly equal to tree height of 15 meters. This is in contrast to some recent measurements by other workers showing a zero-plane displacement nearly equal to tree height and a roughness of 2 or 3 meters. More wind profiles over other stands are needed to better define these relationships.

Neutral conditions were not hard to obtain. Temperature differences of only a few hundredths of a degree C between 0 and 5 meters above the treetops were common in the evening and on overcast afternoons. The wind speed ratio between the 5 m. and 0 m. above tree top levels varied from about 5 in inversion to 3 in neutral and 2 in lapse conditions.

Comparison of actual evapotranspiration as estimated by  
water storage equation and potential evapotranspiration

The water storage equation  $ET = P - RO + S$ , provides a simple means for estimating evapotranspiration for a gaged catchment. On Hubbard Brook catchments, unmeasured seepage past the gaging station is believed minimal because of tight bedrock. Accurate records of precipitation and streamflow over a consecutive 5-year period were used; a water year beginning May 16 when soil moisture levels are uniformly high was selected, thus minimizing year-to-year variation in the storage term.

Air temperature and daylength were used in the Thornthwaite method for estimating potential evapotranspiration by individual days. The period for which potential evapotranspiration was computed coincided with the period in which leaves are normally present on northern hardwoods (May 16 to October 15) in our area. Potential evaporation was also computed for the period from disappearance of snow until leafing out (April 25 to May 15).

Year:	Potential evapotranspiration			Actual evapotranspiration		
	by Thornthwaite method			by water storage equation		
	1/3 of potential:	Potential ET :	Total	Net	Actual	
	April 25-May 15:	May 16-Oct 15:	Potential	Ppt :	Runoff :	ET
	:	:	:	Water yr., May 16-May-15		
1958	.37	17.54	17.91	39.10	21.42	17.68
1959	.56	19.28	19.84	60.20	39.90	20.30
1960	.62	18.67	19.29	42.61	22.94	19.67
1961	.48	19.67	20.15	38.29	20.02	18.27
1962	.45	18.48	18.93	47.98	29.55	18.43
5-year average	.50	18.73	19.23			18.87

Actual evapotranspiration, averaged over 5 years, is 18.87 inches per year. A value of about 19 inches per year is given for the Hubbard Brook area by the U.S. Geological Survey.<sup>1/</sup>

The 5-year average potential evapotranspiration for the growing season, 18.73 inch per year, is probably low. Theoretically, the potential should be greater than the actual evapotranspiration because the concept of potential evapotranspiration assumes that soil water is readily available. Water loss could occur by processes other than transpiration in the leafless period in early spring. Accordingly, one-third of the calculated potential evapotranspiration from April 25 to May 15 was arbi-

<sup>1/</sup> Knox, C. E., and T. J. Nordenson. Average Annual Runoff and Precipitation, New England and New York. U. S. Geological Survey, Hydrological Investigations Atlas HA-7.

trarily added to the growing season potential . This brought the 5-year average potential evapotranspiration to 19.23, slightly more than the actual evapotranspiration determined by the storage equation.

Even with this adjustment, the potential and actual evapotranspiration are remarkably close over the 5-year period. It is possible that the Thornthwaite method underestimates potential evapotranspiration; this is believed to happen in more southern parts of the country. Or there may be inaccuracies in values for the water storage equation--unmeasured losses from the catchments would reduce the computed values of actual evapotranspiration. But the good agreement with the values given in the Hydrologic Atlas indicates that our use of the storage equation is not grossly erroneous. A valid interpretation of the closeness of actual and potential evapotranspiration is that soil moisture is sufficiently available throughout the growing season to meet the full demand made by potential evapotranspiration. Small, numerous storms (35 days of rain greater than .05 inch June through September, 1961, our "driest" summer on record) apparently keep soil moisture levels high enough so potential rates can be nearly met.

The estimates of potential and actual evapotranspiration for individual years appear to be reasonable. In a summer with abundant soil moisture, actual evapotranspiration should be about equal to the potential. In the "wettest" summer of record, 1960, rainfall was 3.3 inches greater than average and actual evapotranspiration was about equal to potential ( $19.67 - 19.29 = .38$  inch greater). The "driest" summer, 1961, with 3.0 inches less rain than average had an actual evapotranspiration 1.88 inch less than potential ( $20.15 - 18.27$ ).

--Bob Pierce  
George Hart  
Tony Federer

## PROJECT 1602 - FLOODS AND WATER YIELD

### Half-cut watersheds

As previously reported, we have logged and silviced halves of watersheds. Treatment started in November 1963 and was virtually completed on Upper-Seven early in the 1964 growing season and on Lower-Six early in the 1965 growing season. This summer, Upper-Seven was treated with 2,4,5-T, 2,4-D and Dalapon (the latter for grass). Lower-Six was treated with 2,4,5-T and 2,4-D.

Appreciable increase in flow by months has been measured as follows (expressed as inches depth over treated area):

<u>Month</u>	<u>Increase in Discharge (area inches)</u>	
	<u>Upper-Seven</u>	<u>Lower-Six</u>
June, 1964	1.96	
August	1.66	
September	1.42	1.16
October	1.08	.48
November	1.64	1.04
December	1.90	
February, 1965	3.78	
April		.90
July	2.16	1.60

It is readily apparent that our inability to treat the two watersheds simultaneously will complicate interpretation of results. Another complication is that before treatment No. 7 discharge was considerably greater than that of No. 6. An important feature of results so far is that sizable increases have occurred in a period of below-average precipitation.

#### Microclimate

We finally succumbed to the pressures of the modern age. We erected two 80-foot TV towers, one in Lower Six that has been cleared and one in Upper Six that is scheduled for clearing in the 1966-67 dormant season. These will be used for extension of our study on the effects of forest clearing on microclimate. Planned measurements at various levels on the towers include air temperature, wind, relative humidity and solar, thermal and total radiation. Radiation measurements will be collected using six of the 20 Economical Radiometers constructed by the Northeastern Station personnel last May.

We have also installed a Kipp and Zonen Solarimeter on the roof of our laboratory. This will give us a much-needed solar radiation reference, and with a minimum of effort because its recorder is equipped with a disc integrator.

#### Miscellaneous

We are attempting to recruit a forester with a specialty in soils but have had no success as yet.

Meetings and training sessions occupied a greater-than-usual portion of time in the period. Reinhart attended the 2-week International Symposium on Forest Hydrology; Hornbeck went to the Allegheny Section, SAF, meeting with the theme "Water...the key to growth". He then attended the 3-weeks statistics course at the University of Georgia.

--Ken Reinhart  
Jim Hornbeck



## PROJECT 1603 - WATERSHED CORRELATION AND SYNTHESIS

This project became official June 24, 1965. It has dual objectives: (1) to assemble, correlate, and synthesize forest watershed research results and associated data for the prediction of the effects of forest watershed management practices on streamflow in the eastern United States, and (2) through research on municipal watersheds and correlative information determine the practices that will meet municipal water-yield and water-quality management needs. Personnel match the objectives in number, if not in elegance. Howard Lull will handle the correlation effort and Irvin Reigner will be in charge of the municipal studies. Cooperative studies will be stressed.

### Hardwood humus

A cooperative effort launched this past summer involves a regional study of hardwood humus accumulations in the Northeast. Litter and humus depths and associated site information are to be measured in specified areas in New Hampshire, Massachusetts, New Jersey, New York, Pennsylvania and West Virginia. All Station watershed projects are involved. Laboratory work (oven-drying, moisture content at 60 cm tension, and loss on ignition) will be handled by cooperator Professor Donald Mader, University of Massachusetts. About one-third of the field work was completed this summer. This study should give quantitative data on the magnitude of hardwood humus accumulation throughout the region; the site factors that govern it; and its hydrological role in water storage.

### Analysis of regional streamflow

At the Pennsylvania State University we are continuing our analysis of streamflow data from 137 watersheds in the Northeast. Our latest computer sheets give us for each watershed and each of the 17 years of record, the shortest one-quarter and one-half flow intervals (the shortest possible periods of time, in days, that are needed for one-quarter or one-half the total annual discharge to runoff), and, for low flows, the longest 1 percent and 5 percent flow intervals. These intervals will be related to selected climatic, topographic, and land-use variables.

### Municipal watershed treatments

Treatments were applied to two recently-calibrated municipal watersheds during the past six months and another will be treated during October. The first, a streamside-vegetation treatment, was made on Newark No. 1 to simulate the streamside brush removal that the city has been doing for the last 40 years. The trees and brush were not removed, in this case, but were injected with ANSAR 160, a fast-acting herbicide.

Many of the trees did not die as quickly as expected, and a number of red maples are still partly alive as this is written 5 months later. We believe the abnormal resistance to the herbicide is the result of a plentiful water supply to these trees. All of them were in the riparian zone.

The second treatment was begun late in September on Newark No. 3. All trees on this 24-acre watershed will be injected with Tordon 22K, which is reputed to be the most powerful hormone-type herbicide developed to date. All lesser vegetation and sprouts will be sprayed early in the next growing season with a portable mist-blower to eliminate transpiration as completely as possible.

The first treatment to be applied to the Baltimore experimental sub-watersheds will begin in October with a riparian area cut on Watershed No. 1. All trees and brush will be cut and the stumps will be sprayed to prevent sprouting.

#### Miscellaneous

At a seminar at Rutgers University early in May, Edward C. Rhodehamel, groundwater geologist for the U.S. Geological Survey, presented a preliminary report on the effect of fire on water yield in the Pine Barrens of New Jersey. The watershed experiment conducted by the Geological Survey and Rutgers on the Lebanon State Forest was burned out in the 1963 fire. Using a single-watershed approach, Mr. Rhodehamel was able to show a significant increase in groundwater recharge caused by the fire.

Senator Edmund S. Muskin of Maine chaired a hearing of a Special Subcommittee on Air and Water Pollution at Philadelphia on June 3. A number of witnesses from interested groups scheduled to testify did not appear. Those that did testify presented little or no evidence of pollution in the Delaware Estuary, even though a serious fish kill had occurred a few weeks earlier.

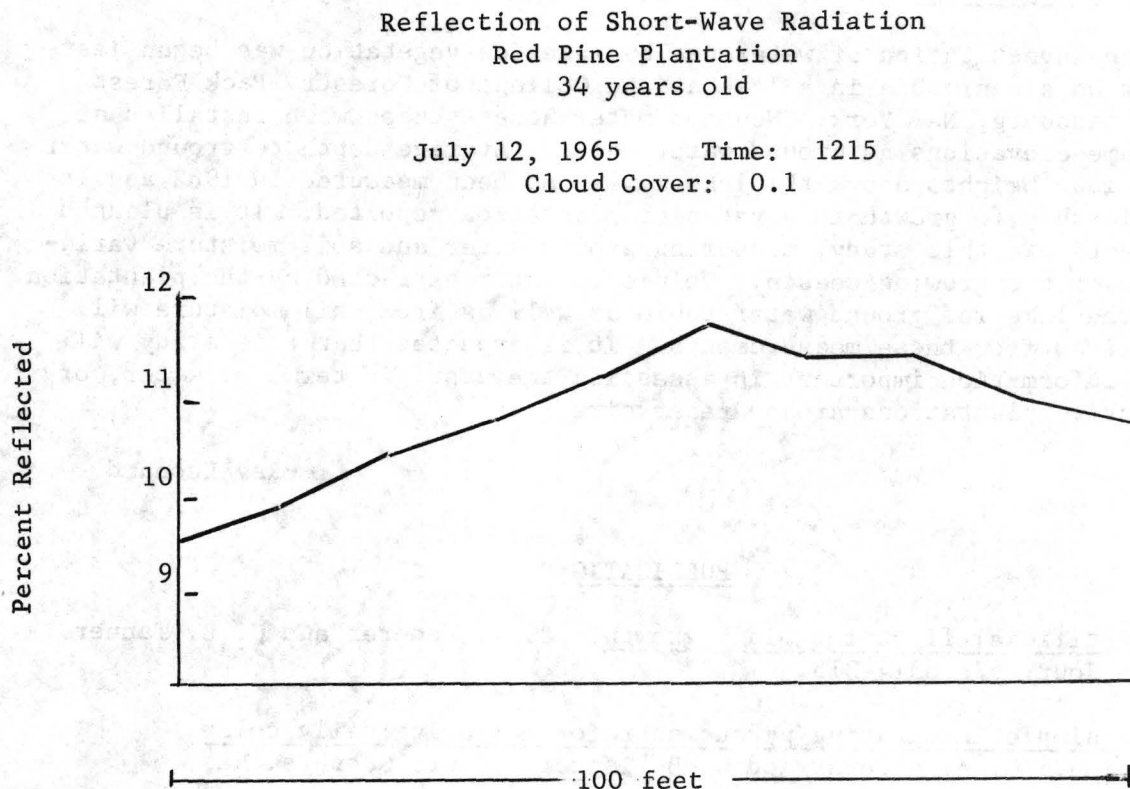
The International Symposium on Forest Hydrology at Penn State was the featured attraction of the past 6 months. Final attendance statistics were: 31 from 21 foreign countries; 22 from U.S. Universities; and 32 from the Forest Service. Sixty five papers were presented plus 20 resumes of research by countries. Bill Sopper wore out a pair of shoes.

## PROJECT 1604 - STREAM REGIMEN AND WATER YIELDS

### Adirondack study

The major effort of the Syracuse project during the past six months has been directed toward the investigation of reflection of short-wave radiation from a 34-year-old Red Pine Plantation. We are passing a downward facing Kipp-Zonen solarimeter along a two cable tramway above the forest canopy. Incoming radiation is measured on an upward facing solarimeter and a reflectivity ratio computed. Some mechanical difficulties were encountered which have since been overcome or pushed into the background. Approximately 2000 individual measurements of reflectivity were taken in July and August under a variety of sky conditions. We plan to operate the system three days a month during the coming year to enable us to sample a variety of seasonal and sky conditions.

A sample from last summer's collection of data looks like the diagram below. Reflectivity appears to vary about 2-3 percent along the 100 foot tramway.





### Streamflow analysis

Application of the "Flow Interval Method" to the discharge data from four differently treated mountain watersheds in the Fernow Experimental Forest has shown that harvesting changes length and time of occurrence of the various flow intervals. In general, the 25- and 50-percent flow intervals may be either lengthened or shortened, depending on the intensity of cut and the number of years since harvest. In nearly every instance, harvesting shortened the length of the 1- and 5-percent intervals.

Dates of mean flow occurrence for the shortest 25- and 50-percent flow intervals were not affected to any extent. The dates of the beginning of the 1- and 5-percent flow intervals were greatly affected, however. The analysis indicated that low flows were starting later in the year due to the increased discharge during the summer.

The results of this study compared favorably with the results of the discharge analysis by Reinhart, Eschner, and Trimble in Station Paper NE-1, 1963.

### Lakeside vegetation

An investigation of water use by lakeside vegetation was begun last summer on a peninsula in a lake at the College of Forestry Pack Forest at Warrensburg, New York. Neutron meter access tubes were installed at the same elevations as ground water wells. Average depth to ground water at various heights above the lake level had been measured in 1962 and its relationship to growth in a red pine plantation reported. It is planned to reactivate this study, measuring ground water and soil moisture variation over the growing season. Volume of water extracted by the plantation from the lake-fed ground water table as well as from soil moisture will be derived from these measurements. It is expected that this study will yield information important in assessing the cost, in terms of water, of protective plantations around reservoirs.

--Ray Leonard

### PUBLICATIONS

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A simple integrating pyranometer for measuring daily solar radiation. C. A. Federer and C. B. Tanner. Jour. Geophys. Res. 70: 2301-2306.

Forest watershed management in the Northeast. Robert S. Pierce. The Main Forester. pp. 48-52.

Problems of obtaining accuracy in streamflow measurements on the Fernow Experimental Forest. James W. Hornbeck. U.S. Forest Service Res. Note NE-29, 8 pp., illus.

Logging and erosion on rough terrain in the east. H. W. Lull and K. G. Reinhart. Proc. Federal Inter-Agency Sedimentation Conference, 1963. Misc. Pub. No. 970, Agr. Res. Serv. pp. 43-47.

Manuscripts submitted:

Evidence of overland flow on forest watersheds. Robert S. Pierce.

New stream-gaging instruments. George E. Hart

New radiation instruments. C. A. Federer.

Sustained winter streamflow from groundmelt. C. A. Federer

An annotated bibliography of watershed research of the Northeast Forest Experiment Station. Howard W. Lull.

The effects of harvesting forest products on water yield in Appalachia. Howard W. Lull and William E. Sopper.

Factors influencing streamflow in the Northeast. Howard W. Lull and William E. Sopper.